COMMUNICATION CHANNEL SELECTING CIRCUIT CORRESPONDING TO RADIO SIGNAL INTENSITY

BACKGROUND OF THE INVENTION

The present invention relates to a circuit for selecting a channel in a communication (transmission-receiving) system having a plurality of channels such as a TDMA system. More particularly, the present invention is directed to a communication channel selecting circuit corresponding to radio signal intensity.

A PHS adopted TDMA-TDD system selects one channel from four channels, from CH1 to CH4(4 channels for receiving and 4 channels for transmission) and performs transmission and receiving. In this TDMA-TDD system, a radio signal received from an antenna is demodulated at a receiving timing, and data is reproduced. To confirm whether the radio signal is able to be demodulated to reproduce the data without deficiencies and has sufficient intensity or not, intensity of a signal, indicating radio signal intensity converted from a radio signal, is measured/monitored at a receiving timing of each of the channels from channel 1 to channel 4.

The intensity of the signal indicating radio signal intensity is judged at the CPU, the CPU selects a receiving channel indicating the highest intensity and, at the same time, it also selects a transmission channel corresponding to the selected receiving channel. A communication channel is thus selected in the conventional system.

The conventional channel selection process by measuring the intensity of the radio signal as described above does however have problems as outlined in the following.

In this instance, the problem is described with reference, as an example, to a family type extension telephone system a handset of which can transmit and receive information by radio signal. When power is applied to a main telephone of an extension telephone system or the system is reset, the operation starts with a timing of the main telephone. The main telephone, starting its operation, measures the intensity of radio signals at its own receiving timing, and selects the most intensive receiving channel. At the time of measuring, if another similar extension telephone system is in use nearby, the main telephone, newly applying power or resetting the system, measures the radio signal intensity of the channel used by another similar extension telephone system, and selects the same or adjacent channel used by another similar extension telephone system.

Accordingly, transmitting the radio signal that overlaps with other radio signals in the channels already used may cause an undesirable disturbance to other radio apparatuses.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a communication channel selecting circuit corresponding to radio signal intensity, without disturbing radio signals in a channel already used by other radio apparatuses, which overcomes the above issues in the related art. This object can be achieved by combinations described in the independent claims. The dependent claims define further advantageous and exemplary combinations of the present invention.

To achieve the object described above, in one aspect of the present invention, there are provided a radio unit which outputs a signal indicating radio

field intensity of a radio signal received through an antenna at a receiving status and transmits a radio signal to the antenna at a transmission status, a control circuit which sets the radio unit to the receiving status even if the radio unit is at a transmission timing, a timing control circuit which outputs timing signals for each of a plurality of channels at a transmission timing, a register which stores a level of the signal outputted from the radio unit at the signal-receiving status in a response to the timing signal, and a communication control circuit which compares the level of signals stored in these registers and selects to communicate in one of the plurality of channels .

Corresponding to the first aspect of the present invention, a communication channel selecting circuit for selecting one of communication channels in which a radio signal is transmitted and received in accordance with a radio signal intensity thereof. The selecting circuit comprises a radio unit outputting an intensity signal indicating the radio signal intensity of the radio signal received through an antenna in a receiving status and transmitting the radio signal to the antenna in a transmission status, a control circuit setting the radio unit to the receiving status even at a transmission timing and outputting a timing signal for each of the channels during the transmission timing, a register storing a level of the intensity signal outputted from the radio unit in response to the timing signal, and a transmission-receiving control circuit comparing the level stored in the register and selecting one of the channels for transmission and receiving.

The summary of the invention does not necessarily describe all necessary features of the present invention. The present invention may also be a sub-combination of the above described features. The above and other features and advantages of the present invention will become more apparent from the following

description of embodiments taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a communication channel selecting circuit corresponding to radio signal intensity according to a first embodiment of the present invention.

Fig. 2 is a timing chart of the operation of the communication channel selecting circuit corresponding to radio signal intensity shown in Fig. 1.

Fig. 3 is a block diagram of a communication channel selecting circuit corresponding to radio signal intensity embodying the second embodiment of the present invention.

Fig. 4 is a timing chart of the operation of the communication channel selecting circuit corresponding to radio signal intensity shown in Fig. 3.

DETAILED DESCRIPTION OF THE INVENTION

Preferred embodiments of the present invention will now be described with reference to accompanying drawings, which do not intend to limit the scope of the present invention, but exemplify the invention. All of the features and the combinations thereof described in the embodiment are not necessarily essential to the invention.

Fig. 1 is a block diagram showing a communication channel selecting circuit corresponding to radio signal intensity according to the first embodiment of the present invention.

An antenna 101, which transmits and receives a radio signal, connects to a radio unit 102. The radio unit 102 converts the radio signal to an RSSI signal,

which indicates radio signal intensity and is an analog signal, and outputs the RSSI signal. The RSSI signal that indicates the radio signal intensity is inputted to an A/D converter 103. The A/D converter 103 digitizes the inputted analog signal and outputs a digital ADO signal or a result signal of the analogue/digital conversion.

In each of the registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214, which are connected to the A/D converter 103, the ADO, a result signal of the A/D conversion as a digital signal, is inputted and the registers store the inputted signal. These registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214, are timing controlled by timing signals from LT1 to LT4 and from LT21 to LT24, outputted from a timing control circuit 221. The timing control circuit 221 also outputs a switching signal TXRX that operates a switching control between transmission/receiving status of the radio unit 102. When this switching signal TXRX is "H", the radio unit 102 is at the receiving status and receives the radio signal from the antenna; when the TXRX is "L", the radio unit 102 is at a transmission status and outputs a radio signal from a transmission signal processing circuit, which is not shown in the figure, to the antenna.

The registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the

receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214, are connected to CPU 241 via a data bus 231. This CPU 241 compares and assesses the digitized signal indicating the radio signal intensity stored in the registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214. Then, the assessed result is sent to a communication control circuit 242 and the communication control circuit 242 selects a transmission and a receiving channel.

In this instance CPU 241 is also connected to the timing control circuit 221, and CPU 241 controls the timing signals from LT1 to LT4 and from LT21 to LT24.

Next, referring to Fig. 2, the operation of the communication channel selecting circuit in accordance with the radio signal intensity according to the present invention will be described. Fig. 2 is a timing chart showing the operation of the communication channel selecting circuit corresponding to radio signal intensity shown in Fig. 1. A PHS using the TDMA-TDD system has four channels. In other words, the receiving channels from CH1 to CH4 and the transmission channels from CH1 to CH4 are allocated in a single frame, which is a predetermined period; and this frame is repeated.

In this embodiment, the switching signal TXRX is held at "H" in the frame shown in the figure. This means the radio unit 102 is at the receiving status for the entire period in the frame shown in the figure. That is, the radio unit 102 is not at

the transmission status but rather at the receiving status while the period that transmission channels from CH1 to CH 4 are allocated, which is originally a transmission timing.

RSSI, a signal indicating the receiving signal intensity outputted from the radio unit 102, continues to be outputted, because the radio unit 102 is under a receiving status while the switching signal period TXRX is "H" level. On the other hand, corresponding to the timing allocated receiving channels from CH1 to CH4 and transmission channels from CH1 to CH4 by the timing signal control circuit 221 controlled by the CPU 241, the timing signals from LT1 to LT4 and from LT21 to LT24 are sent to the registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214.

Each of the registers, from the A/D conversion result storage register for the receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114 and from the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214, stores the ADO as a result signal of the A/D conversion outputted by the A/D converter 103, corresponding to the timing signals from LT1 to LT4 and from LT21 to LT24 received by each of the registers.

In Fig. 2, the ADO as a result signal of A/D conversion, that is an output from the A/D converter, is not shown, but the RSSI is shown as a substitution for ADO; because the ADO is the digitized RSSI indicating the receiving signal intensity.

Subsequently, not shown in Fig. 2, the CPU 241 compares and assesses the data stored in the registers, the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214; selects a channel not used from the transmission channels from CH1 to CH4; and conveys it to the communication control circuit 242. In particular, the CPU 241 assesses the data that does not reach a predetermined level from the data stored in the registers, the A/D conversion result storage register for the transmission channel-1 211 to the A/D conversion result storage register for the transmission channel-4 214, and conveys it to the communication control circuit 242. When the intensity of the radio signal at a certain transmission channel exceeds a predetermined level, other radio apparatus of a similar kind may use the transmission channel in a respectable probability.

The communication control circuit 242 selects a communication channel as directed by the CPU 241. In particular, the communication control circuit 242 selects the transmission channel directed by the CPU 241 and the receiving channel corresponding to that transmission channel and decides the communication channel.

In this instance, the data stored in the registers, the A/D conversion result storage register for receiving channel-1 111 to the A/D conversion result storage register for the receiving channel-4 114, are not used for the selection of the communication channel, but used for monitoring a receiving status in a situation such as a handset of a family type extension telephone where used over distances the radio signal becomes weak.

After the operation to select the communication channel shown in Fig. 2 is completed, not shown in Fig. 2, in the next frame, the switching signal TXRX

returns to the original mode. The switching signal TXRX becomes "H" level while the period corresponds to the receiving channels and sets the radio unit 102 at the receiving status, on the other hand, while the period corresponds to the transmission timing, TXRX becomes "L" level and sets the radio unit 102 at the transmission status.

As described above, in the first embodiment of the present invention, the radio unit 102 is at the receiving status even in the period allocated to the transmission channels and the intensity of the radio signal is measured for the period, and a communication channel for use is selected corresponding to this intensity. Therefore, avoiding channels that are the same or adjacent to the channels used by other radio apparatuses of similar kinds in a neighboring area, a channel that does not disturb other radio apparatuses can be selected and used.

Fig. 3 shows the circuit diagram of a communication channel selecting circuit corresponding to radio signal intensity according to a second embodiment of the present invention. In Fig. 3, the same numerals for the same components in Fig. 1 are used and the descriptions of them are omitted.

A communication channel selecting circuit of the second embodiment, the registers from a channel-1 A/D conversion result storage register 311 to a channel-4 A/D conversion result storage register 314 are connected to an A/D converter 103. An A/D conversion result signal ADO as a digital signal is inputted to each of the registers from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, each of the registers from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314 store the inputted signal. These registers from the channel-1 A/D conversion result storage register 311 to

the channel-4 A/D conversion result storage register 314 are timing controlled by the timing signals from LT31 to LT34 outputted from a timing control circuit 321. The timing control circuit 321 also outputs a switching signal TXRX to control switching between transmission/receiving status of a radio unit 102.

The registers from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314 are connected to a CPU 341 via a data bus 231. This CPU 341 compares and assesses the digitized signal indicating the radio intensity, which is stored in the registers from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314. Then, the assessed result is sent to a communication control circuit 242.

The CPU 341 is also connected to the timing control circuit 321; the CPU 341 controls timing signals from LT31 to LT34.

Next, referring to Fig. 4, the operation of the communication channel selecting circuit corresponding to radio signal intensity according to the second embodiment of the present invention is described. Fig. 4 is a timing chart showing the operation of the communication channel selecting circuit corresponding to radio signal intensity shown in Fig. 3.

RSSI, the signal indicating the receiving signal intensity outputted from the radio unit 102, continues outputting during the period the switching signal TXRX is "H" level, because the radio unit 102 is at the transmission status. On the other hand, corresponding to the timing allocated receiving channels from CH1 to CH4 and transmission channels from CH1 to CH4 by the timing signal control circuit 321 controlled by the CPU 341, the timing signals from LT31 to LT34 are sent to the registers, from the channel-1 A/D conversion result storage register 311 to the

channel-4 A/D conversion result storage register 314.

Corresponding to the timing signals from LT31 to LT34 received by each of the registers, each of the registers, from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, stores the ADO as a result signal of A/D conversion outputted by the A/D converter 103.

In this instance, the timing signals from LT31 to LT34 are sent twice in one frame, the timings of which receive channels from CH1 to CH 4 are allocated and the timings of which transmission channels from CH1 to CH4 are allocated. Thus, in the registers, from the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, two amounts of data, data indicating the radio signal intensity at the timings that the receiving channels from CH1 to CH4 are allocated and data indicating the radio signal intensity at the timings that the transmission channels from CH1 to CH4 are allocated, is stored.

Following this, not shown in Fig. 4, the CPU 341 compares data indicating receiving signal intensity of the radio signals at the timing allocated to the transmission channels from CH1 to CH4 from the data stored in the registers, the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, assesses, selects a transmission channel not in use from channels CH1 to CH4, and transmits to the communication control circuit 242. In particular, the CPU 341 determines the data indicating receiving signal intensity of the radio signals at the timing allocated to the transmission channels from CH1 to CH4 that does not reach a predetermined level from the data stored in the registers, the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, and transmits it to the

communication control circuit 242.

Here, the data indicating receiving signal intensity of the radio signals at the timing allocated to the receiving channels from CH1 to CH4 stored in the registers, the channel-1 A/D conversion result storage register 311 to the channel-4 A/D conversion result storage register 314, is not used for the selection of the communication channel, but rather used for monitoring the receiving status in such a situation as a handset of a family type extension telephone distances and the radio signal becomes weak.

As described above, applying the second embodiment of the present invention, in addition to the advantage of the first embodiment, the number of A/D conversion result storage registers can be decreased and the circuit can be simplified and scale-down.

In the above described embodiments, configuration of 4 channels is chosen as an example for explanation; the present invention can be applied to any configuration with a plurality of channels. The example that the radio unit is set at the receiving status for all transmission timing in the predetermined frame is explained; the radio unit can be set at a receiving status for a transmission timing of a certain channel and the configuration may detect if a certain channel is a usable channel. Furthermore, it is possible to use only one register, or to share the registers in order to reduce the number of the registers. In this case, the register(s) stores data at a plurality of timings.

As described above, according to the present invention, a radio unit is set at the receiving status and the intensity of the radio signal is measured during the period allocated to the transmission status, and corresponding to this intensity, the channel to communicate is selected. Therefore, while avoiding the channel

occupied by other similar radio apparatus nearby, a channel, which does not disturb or interfere with the other radio apparatus, can be selected and used.

Although the present invention has been described by way of exemplary embodiments, it should be understood that many changes and substitutions may be made by those skilled in the art without departing from the spirit and the scope of the present invention which is defined only by the appended claims.